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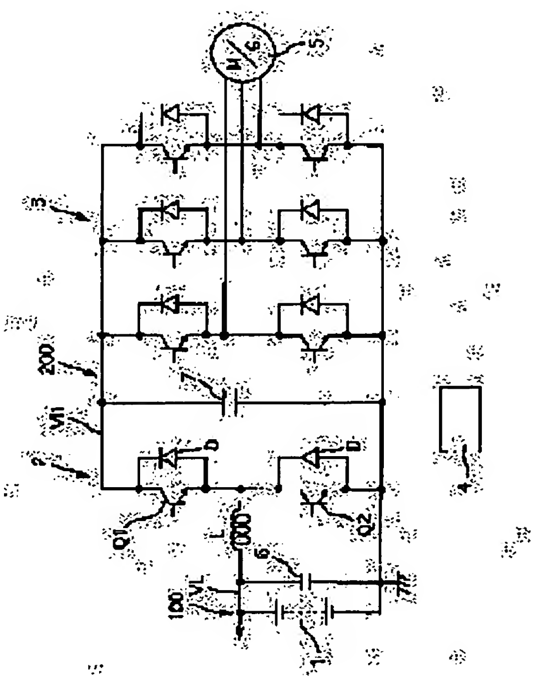
(54) DRIVE GEAR FOR AUTOMOTIVE DYNAMO-ELECTRIC MACHINE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a drive gear for an automotive dynamo-electric machine that can suppress voltage fluctuations of the power source caused by the operating condition of the power-fed automotive dynamo-electric machine being switched.
SOLUTION: The duty ratio of the switching elements Q1, Q2 on the DC-DC converter is feedback controlled in order to make the voltage 200 of the high voltage power source system 200 converge within a prescribed target range. If switching occurs between power operation and regenerative operation in controlling the switching elements Q1, Q2, the sharp change of the circuit condition during switching may cause a sharp change in the voltage and current on the low voltage power source system 100, adversely affecting the battery 1 and other low voltage components of the low voltage power source system 100. Therefore, the power transmission direction of the DC-DC converter 2 is switched before and after switching, as well as the maximum duty ratio of the switching elements Q1, Q2 so that the voltage and the current of the low voltage power source system 100 stay within the tolerance of the battery 1 of the low voltage power source system 100.



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CLAIMS

[Claim(s)]
[Claim 1] The high-voltage electrical power system which carries out bidirectional power transfer through the dynamo-electric machine for cars and inverter equipment of the high voltage which take charge of a part of generating of transit power, and regeneration [at least], The low-battery electrical power system which has the dc-battery of a low battery and generates a low battery rather than said high-voltage electrical power system, The DC-DC converter which is arranged among said both electrical power systems, and controls the bidirectional power transfer between said both electrical power systems, In the dynamo-electric machine driving gear for cars equipped with the control section which carries out PWM control of the switching element built in said DC-DC converter said control section While carrying out feedback control of the duty ratio of said switching element so that the electrical potential difference of said high-voltage electrical power system may be completed as the predetermined target range It responds to a change in the powering movement of said dynamo-electric machine for cars, and regeneration actuation. Or bidirectional DC-DC converter equipment for cars characterized by changing the maximum duty ratio of said switching element in the voltage variation control direction of said low-battery electrical power system according to electrical-potential-difference change of said high-voltage electrical power system accompanying said change.
[Claim 2] In the dynamo-electric machine driving gear for cars according to claim 1 said DC-DC converter Said switching element by the side of the high side which a series connection is carried out and is connected to the both ends of said high-voltage electrical power system, and said switching element by the side of a low side, [each other] It has the reactor which connects the node of said both switching elements, and the high order edge of said low-battery electrical power system. Said control section PWM control of the switching element by the side of said high side is carried out within the limits of the first maximum duty ratio at the time of the power transmission to said low-battery electrical power system from said high-voltage electrical power system, i.e., said regeneration actuation. The dynamo-electric machine driving gear for cars characterized by carrying out PWM control of the switching element by the side of said low side within the limits of the second maximum duty ratio at the time of the power transmission to said high-voltage electrical power system from said low-battery electrical power system, i.e., said powering movement.
[Claim 3] It is the dynamo-electric machine driving gear for cars characterized by said control section changing said maximum duty ratio based on the detecting signal relevant to the temperature or the current of said dc-battery in the dynamo-electric machine driving gear for cars according to claim 1.
[Claim 4] The high-voltage electrical power system which carries out bidirectional power transfer through the dynamo-electric machine for cars and inverter equipment of the high voltage which have the dc-battery of the high voltage and take charge of a part of generating of transit power, and regeneration [at least], The low-battery electrical power system which has the dc-battery of a low battery and generates a low battery rather than said high-voltage electrical power system, The DC-DC converter which is arranged among said both electrical power systems, and controls the bidirectional power transfer between said both electrical power systems, In the dynamo-electric machine driving gear for cars equipped with the control section which carries out PWM control of the switching element built in said DC-DC converter said control section The dynamo-electric machine driving gear for cars characterized by controlling the power transmission condition of self to the sense which controls the voltage variation of said high-voltage electrical power system by allowable-current within the limits of the dc-battery of said low battery according to sudden change of said high-voltage electrical power system accompanying said sudden change, corresponding to sudden change of the operating state of said dynamo-

electric machine for cars.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the dynamo-electric machine driving gear for cars which has a bidirectional DC-DC converter in detail about the dynamo-electric machine driving gear for cars.
[0002]
[Description of the Prior Art] The dynamo-electric machine for cars which performs engine starting operation and generation-of-electrical-energy actuation further for car electric load electric supply in addition to the dynamo-electric machine for cars which performs only generating of transit power and regeneration, the torque assistant actuation as those actuation, or regenerative-braking actuation is known. Thus, usually as a dynamo-electric machine for cars which can change suitably electric actuation and generation-of-electrical-energy actuation, the brush loess synchronous machine an alternating current drive is carried out [a synchronous machine] by the inverter circuit is adopted.
[0003] Although it is desirable to consider as a high-voltage specification as much as possible for the miniaturization of the inverter circuit which drives a dynamo-electric machine and it, or the improvement in effectiveness as for these dynamo-electric machines for cars, since a mounted dc-battery cannot but use the thing of defined predetermined low-battery rating, it needs to interpose the DC-DC converter in which bidirectional power transfer is possible between a mounted dc-battery and an inverter circuit.
[0004]
[Problem(s) to be Solved by the Invention] However, in the dynamo-electric machine driving gear for cars which supplies electric power to the dynamo-electric machine for cars with the above-mentioned bidirectional DC-DC converter, the electrical potential difference of a low-battery electrical power system or a high-voltage electrical power system may overshoot by sudden change of a circuit condition at the time of a change in electric actuation of the dynamo-electric machine for cars, and generation-of-electrical-energy actuation, and it may become excessive, and may have a bad influence on the electrical machinery and apparatus connected to a dc-battery or it.
[0005] This invention is made in view of the above-mentioned trouble, and it sets it as the purpose to offer the dynamo-electric machine driving gear for cars which can inhibit the voltage variation of the electrical power system by the operating state change of the dynamo-electric machine for cars which supplies electric power.
[0006]
[Means for Solving the Problem] The high-voltage electrical power system in which the dynamo-electric machine driving gear for cars according to claim 1 carries out bidirectional power transfer through the dynamo-electric machine for cars and inverter equipment of the high voltage which take charge of a part of generating of transit power, and regeneration [at least], The low-battery electrical power system which has the dc-battery of a low battery and generates a low battery rather than said high-voltage electrical power system, The DC-DC converter which is arranged among said both electrical power systems, and controls the bidirectional power transfer between said both electrical power systems, In the dynamo-electric machine driving gear for cars equipped with the control section which carries out PWM control of the switching element built in said DC-DC converter said control section While carrying out feedback control of the duty ratio of said switching element so that the electrical potential difference of said high-voltage electrical power system may be completed as the predetermined target range According to electrical-potential-difference change of said high-voltage electrical power system accompanying said change, it is characterized by changing the maximum duty ratio of said

switching element in the voltage variation control direction of said low-battery electrical power system, corresponding to a change in the powering movement of said dynamo-electric machine for cars, and regeneration actuation.
[0007] That is, according to this configuration, feedback control of the duty ratio of the switching element of a DC-DC converter is carried out so that the electrical potential difference of a high-voltage electrical power system may be completed as the predetermined target range. In this case, if a change produces control of a switching element in a powering movement and regeneration actuation, the electrical potential difference and current of a low-battery electrical power system will change suddenly by the circuit condition sudden change at the time of a change, and a bad influence will arise to the dc-battery of a low-battery electrical power system.
[0008] So, with this configuration, the value of the maximum duty ratio of a switching element is also changed to coincidence so that the electrical potential difference and current of a low-battery electrical power system may be settled in the tolerance of the dc-battery of a low-battery electrical power system before and after a change at the power transmission direction change sexagenary-cycle coincidence of a DC-DC converter. The change of the mode of operation of the dynamo-electric machine for cars can be performed inhibiting the bad influence to a dc-battery, since the overshoot electrical potential difference superimposed on power-source Rhine of a low-battery electrical power system at the time of the change of the operating state (the power transmission direction) of a DC-DC converter can be controlled by this.
[0009] A configuration according to claim 2 is set to the dynamo-electric machine driving gear for cars according to claim 1. Further Said switching element by the side of the high side by which the series connection of said DC-DC converter of each other is carried out, and it is connected to the both ends of said high-voltage electrical power system, and said switching element by the side of a low side, It has the reactor which connects the node of said both switching elements, and the high order edge of said low-battery electrical power system. Said control section carries out PWM control of the switching element by the side of said high side within the limits of the first maximum duty ratio at the time of the power transmission to said low-battery electrical power system from said high-voltage electrical power system, i.e., said regeneration actuation. It is characterized by carrying out PWM control of the switching element by the side of said low side within the limits of the second maximum duty ratio at the time of the power transmission to said high-voltage electrical power system from said low-battery electrical power system, i.e., said powering movement.
[0010] That is, according to this configuration, the effectiveness of the claim 1 above-mentioned publication is realizable with a simple configuration.
[0011] It is characterized by a configuration according to claim 3 changing said maximum duty ratio based on the detecting signal on the dynamo-electric machine driving gear for cars according to claim 1, and further relevant to the temperature or the current of said dc-battery in said control section.
[0012] Since the maximum duty ratio at the time of the above-mentioned dc-battery charge and the maximum duty ratio at the time of discharge of the above-mentioned dc-battery are changed according to changing the allowable voltage (it being the minimum electrical potential difference at the time of the maximum electrical potential difference and discharge at the time of charge) of the dc-battery of a low-battery electrical power system according to the temperature and current, respectively according to this configuration, even if the temperature and the current of a dc-battery change, increase of the bad influence to the dc-battery by the above-mentioned change is avoidable.
[0013] The high-voltage electrical power system which carries out bidirectional power transfer through the dynamo-electric machine for cars and inverter equipment of the high voltage which the dynamo-electric machine driving gear for cars according to claim 4 has the dc-battery of the high voltage, and take charge of a part of generating of transit power, and regeneration [at least], The low-battery electrical power system which has the dc-battery of a low battery and generates a low battery rather than said high-voltage electrical power system, The DC-DC converter which is arranged among said both electrical power systems, and controls the bidirectional power transfer between said both electrical power systems, In the dynamo-electric machine driving gear for cars equipped with the control section which carries out PWM control of the switching element built in said DC-DC converter Said control section is characterized by controlling the power transmission condition of self to the sense which controls the voltage variation of said high-voltage electrical power system by allowable-current within the limits of the dc-battery of said low battery according to sudden change of said high-voltage electrical power system accompanying said sudden change, corresponding to sudden change of the operating

state of said dynamo-electric machine for cars.
[0014] That is, since according to this configuration drive control of the DC-DC converter is carried out in the tolerance of the dc-battery of a low-battery electrical power system in order that a high-voltage electrical power system and a low-battery electrical power system may inhibit the voltage variation of the dc-battery of a high-voltage electrical power system in two electrical power systems which have a dc-battery, respectively, the voltage variation of a high-voltage electrical power system can be reduced.
[0015]
[Embodiment of the Invention] The suitable embodiment of the dynamo-electric machine driving gear for cars of this invention is explained with reference to drawing 1 .
[0016] (Whole configuration) The synchronous machine with which the dc-battery (low voltage dc-battery) of the low-battery electrical power system 100 and 2 make a bidirectional DC-DC converter (DC-DC converter) and the controller for [3] DC-DC converter control in the inverter circuit of a three phase and 4 (control section), and, as for 5, 1 makes a car transit motor, and 6 and 7 are smoothing capacitors.
[0017] DC-DC converter 2 consists of a switching element Q1 by the side of the high side which consists of a reactor L and IGBT which has the flywheel diode D, respectively, and a switching element Q2 by the side of a low side. Reactor L connects the node of both the switching elements Q1 and Q2, and the high order edge of the low voltage dc-battery 1, the other end of the switching element Q1 by the side of a high side is connected to high potential power-source Rhine VH of the high-voltage electrical power system 200, and the other end of the switching element Q2 by the side of a low side is grounded. VL is high potential power-source Rhine of the low-battery electrical power system 100, and has connected Reactor L and the high order edge of the low voltage dc-battery 1.
[0018] An inverter circuit 3 is a three phase inverter circuit of the common knowledge which comes to carry out pair [every] antiparallel connection of six IGBT(s) and the six flywheel diodes, changes the direct-current high voltage of the high-voltage electrical power system 200 into a three-phase-alternating-current electrical potential difference, and is impressing it to the armature coil of the three phase synchronous machine 5. An inverter circuit 3 is controlled by the controller for inverter control which is not illustrated, and impresses the three-phase-alternating-current electrical potential difference of a predetermined phase to the armature winding of a synchronous machine 5 according to the rotator location of a synchronous machine 5. In addition, the above-mentioned predetermined phases of this three-phase-alternating-current electrical potential difference differ in the time of generation-of-electrical-energy actuation and electric actuation. That is, the above-mentioned controller for inverter control changes generation-of-electrical-energy actuation and electric actuation of a synchronous machine 5 according to the demand of a car by changing the above-mentioned predetermined phase of a three-phase-alternating-current electrical potential difference on the basis of the rotator location of a synchronous machine 5. Since these control is already common knowledge, still more detailed explanation is omitted.
[0019] It has the function to restrict the duty ratio to under the predetermined maximum duty ratio on the occasion of the mode-of-operation change of bidirectional DC-DC converter 2 while carrying out feedback control of the controller 4 so that the electrical potential difference of high potential power-source Rhine VH may become predetermined desired value.
[0020] (Basic actuation) Since actuation differs in the time of electric actuation (powering movement) of the dynamo-electric machine 5 for cars, and generation-of-electrical-energy actuation (regeneration actuation), sequential explanation of both the actuation is given.
[0021] First, the base of the DC-DC converter control in electric actuation (powering movement) is explained below.
[0022] The low voltage dc-battery 1 needs to supply electric power to electric actuation (powering movement) in need power at an inverter circuit.
[0023] Then, a controller 4 carries out PWM switching of the switching element Q2 by the side of a low side within the limits of the first duty ratio. That is, if a switching element Q2 is turned on, a current will flow through Reactor L and a switching element Q2 from the low voltage dc-battery 1, electromagnetic energy is accumulated in Reactor L, and if a switching element Q2 is intercepted, Reactor L will pass a current to high potential power-source Rhine VH through the flywheel diode D which was going to maintain the current condition and was connected to the switching element Q1 by the side of a high side, and reverse juxtaposition.

Hereafter, the low voltage dc-battery 1 supplies electric power to an inverter circuit 3 in direct current power continuously by this repeat.
[0024] Moreover, controllers 4 decrease in number the duty ratio of a switching element Q2 by the increment in the electrical potential difference of high potential power-source Rhine VH, and are performing feedback control which increases the duty ratio of a switching element Q2 by reduction of the electrical potential difference of high potential power-source Rhine VH.
[0025] By this, if the electrical potential difference of high potential power-source Rhine VH increases, the are recording electromagnetic energy of Reactor L will decrease by duty ratio reduction of a switching element Q2, the output voltage of DC-DC converter 2 will decline, conversely, if the electrical potential difference of high potential power-source Rhine VH decreases, the are recording electromagnetic energy of Reactor L will increase according to duty ratio increase of a switching element Q2, the output voltage of DC-DC converter 2 will increase, and the electrical potential difference of high potential power-source Rhine VH will be maintained in the predetermined range.
[0026] Therefore, the increment in the duty ratio of a switching element Q2 causes increase of the discharge current of the low voltage dc-battery 1. Then, the duty ratio of a switching element Q2 is restricted to under the predetermined maximum duty ratio so that the discharge current of the low voltage dc-battery 1 may become under the permission maximum discharge current value. In addition, it may be intermittent in a switching element (complementary) Q1 with a pattern contrary to intermittence of a switching element Q2.
[0027] Next, the base of control of the DC-DC converter in generation-of-electrical-energy actuation (regeneration actuation) is explained below.
[0028] At the time of generation-of-electrical-energy actuation (regeneration actuation), the low voltage dc-battery 1 needs to absorb need power from an inverter circuit.
[0029] Then, a controller 4 carries out PWM switching of the switching element Q1 by the side of a high side within the limits of the second duty ratio. That is, if a switching element Q1 is turned on, a current will flow from high potential power-source Rhine VH to the low voltage dc-battery 1 through Reactor L, electromagnetic energy is accumulated in Reactor L, and if a switching element Q1 is intercepted, Reactor L will pass a current to the low voltage dc-battery 1 through the flywheel diode D which was going to maintain the current condition and was connected to the switching element Q2 by the side of a low side, and reverse juxtaposition. Hereafter, electric power is continuously supplied to the low voltage dc-battery 1 by this repeat in direct current power from an inverter circuit 3.
[0030] Moreover, a controller 4 increases the duty ratio of a switching element Q1 by the increment in the electrical potential difference of high potential power-source Rhine VH, and is performing feedback control which decreases the duty ratio of a switching element Q2 by reduction of the electrical potential difference of high potential power-source Rhine VH.
[0031] By this, if the electrical potential difference of high potential power-source Rhine VH increases, the are recording electromagnetic energy and the dc-battery charging current of Reactor L will increase by the increment in a duty ratio of a switching element Q1, and the electrical potential difference of high potential power-source Rhine VH will fall. On the contrary, if the electrical potential difference of high potential power-source Rhine VH decreases, the are recording electromagnetic energy and the dc-battery charging current of Reactor L will decrease by duty ratio reduction of a switching element Q1, the electrical potential difference of high potential power-source Rhine VH will increase, and the electrical potential difference of high potential power-source Rhine VH will be maintained in the predetermined range.
[0032] Therefore, the increment in the duty ratio of a switching element Q1 causes increase of the charging current of the low voltage dc-battery 1. Then, the duty ratio of a switching element Q1 is restricted to under the predetermined maximum duty ratio so that the charging current of the low voltage dc-battery 1 may become under the permission maximum charging current value. In addition, it may be intermittent in a switching element (complementary) Q2 with a pattern contrary to intermittence of a switching element Q1.
[0033] Furthermore, explanation changes the electrical potential difference of high potential power-source Rhine VL of the low-battery electrical power system 100 in the time of charge and discharge. Although it does not have nothing profit of charge if this does not set up more highly than the open circuit voltage the applied voltage at the time of charge of the low voltage dc-battery 1, the terminal voltage at the time of discharge of the low voltage dc-battery 1 is because it cannot but become lower than open circuit voltage by the voltage drop by

the internal resistance. Although an electrical-potential-difference change of high potential power-source Rhine VL of the above-mentioned low-battery electrical power system 100 at the time of electric actuation (powering movement) and generation-of-electrical-energy actuation (regeneration actuation) may be made compulsorily, leaving above-mentioned quantity potential power-source Rhine VH to the feedback control for fixed-izing can also carry out automatically.

[0034] That is, since the electrical potential difference of high potential power-source Rhine VH becomes high quickly if charge of the low voltage dc-battery 1 does not work at the time of regeneration actuation, according to it, the duty ratio of a switching element Q1 increases quickly, the electrical potential difference of high potential power-source Rhine VL of the low-battery electrical power system 100 rises, and it comes to be able to perform charge of a dc-battery 1 smoothly. On the contrary, since the electrical potential difference of high potential power-source Rhine VH falls quickly, the duty ratio of a switching element Q2 increases quickly, the electrical potential difference of high potential power-source Rhine VL of the low-battery electrical power system 100 falls, and discharge of a dc-battery 1 comes to be able to do it smoothly according to it, if charge of the low voltage dc-battery 1 does not work a powering movement.

[0035] In a change in the electric actuation from regeneration actuation, only a predetermined short time carries out the forcible set of the duty ratio of a switching element Q2 at a predetermined value, without leaving it to the above-mentioned feedback control. In addition, by this Supply power to high potential power-source Rhine VH from the low voltage dc-battery 1 promptly, and the sag of high potential power-source Rhine VH is prevented. In a change in the regeneration actuation from electric actuation, only a predetermined short time carries out the forcible set of the duty ratio of a switching element Q1 at a predetermined value. On the contrary, by this Power can be promptly supplied to the low voltage dc-battery 1 from high potential power-source Rhine VH, and electrical-potential-difference increase of high potential power-source Rhine VH can also be prevented. Of course, after the above-mentioned predetermined short-time progress needs to return to the usual above-mentioned feedback control in this case.

[0036] (Explanation of a controller 4) Next, the controller 4 which controls the above-mentioned DC-DC converter is explained in more detail with reference to drawing 2 .

[0037] As for a comparator, and 46 and 47, the microcomputer for analog threshold electrical potential differences in 40, and 41-45 are [an AND circuit and 48] change circuits.

[0038] A microcomputer 40 is a microcomputer which sets up the maximum duty ratio of the switching element Q2 at the time of a powering movement, and the maximum duty ratio of the switching element Q1 at the time of regeneration actuation. It is inputted into a microcomputer 40 from the sensor which the analog signal electrical potential difference proportional to the temperature and the current of the low voltage dc-battery 1 does not illustrate, and these analog signal electrical potential difference is changed into a digital signal by the A/D converter built in the microcomputer 40.

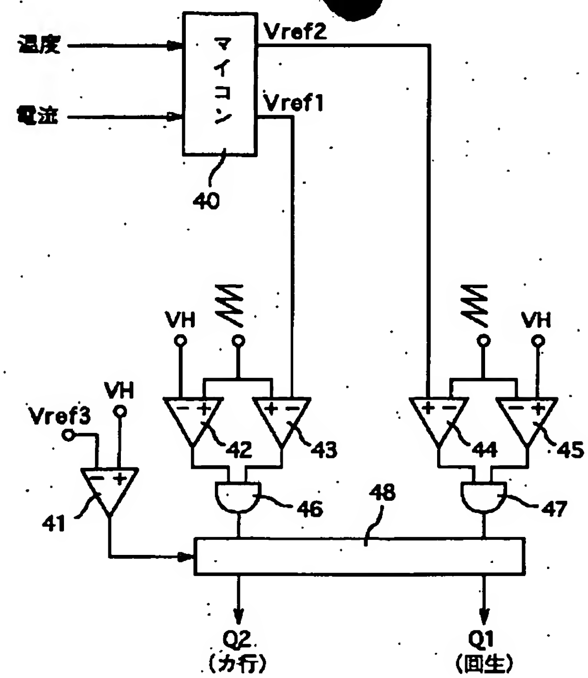
[0039] A microcomputer 40 amends the maximum duty ratio of the switching element Q2 at the time of a powering movement, and the maximum duty ratio of the switching element Q1 at the time of regeneration actuation according to the temperature and the current of the inputted low voltage dc-battery 1. If it explains concretely, the microcomputer 40 will hold the map in which the relation between the temperature of the low voltage dc-battery 1, a current, and the amount of maximum duty ratio amendments is shown, and will calculate the amount of amendments of the maximum duty ratio from a map according to the temperature and the current which were inputted. Furthermore, the amount of amendments is changed in the direction which will make the maximum duty ratio small if the temperature of the low voltage dc-battery 1 is high when it explains, and if the current of the low voltage dc-battery 1 is large, the amount of amendments will be changed in the direction which makes the maximum duty ratio small. Thereby, the temperature of the low voltage dc-battery 1 is high, or when a current is large, the maximum duty ratio can be made small, the maximum current of the low voltage dc-battery 1 can be fallen, and the additional generation of heat or specification condition aggravation of the low voltage dc-battery 1 by increase of an additional current can be prevented.

[0040] D/A conversion of the maximum duty ratio of the switching element Q2 at the time of the powering movement called for with the microcomputer 40 and the maximum duty ratio of the switching element Q1 at the time of regeneration actuation is carried out within a microcomputer 40, and they are outputted to comparators 43 and 45 according to an individual. In addition, Vref1 is an analog threshold electrical potential difference equivalent to the maximum duty ratio of the switching element Q2 at the time of a powering movement, and

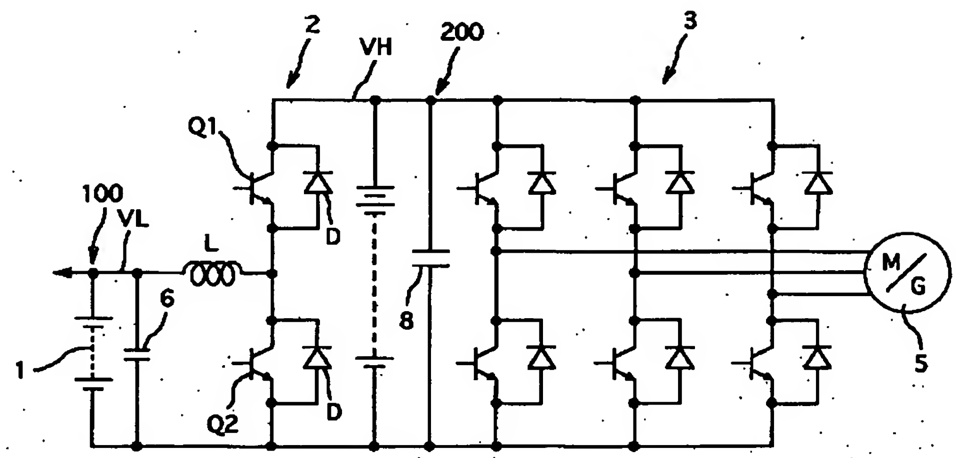
Vref2 is an analog threshold electrical potential difference equivalent to the maximum duty ratio of the switching element Q1 at the time of regeneration actuation.
[0041] Although a comparator 41 is a circuit which distinguishes a powering movement and regeneration actuation, it may receive the signal which distinguishes a powering movement and regeneration actuation from the controller which controls the inverter circuit 3 which omitted and described this above.
[0042] Furthermore, if it explains, the electrical potential differences of high potential power-source Rhine VH of the high-voltage electrical power system 200 differ considerably in the time of a powering movement and regeneration actuation, it is low at the time of a powering movement, and since it becomes high at the time of regeneration actuation, a comparator 41 will output ** high level at the time of regeneration actuation, and will output a low level at the time of a powering movement.
[0043] A comparator 41 controls the signal change circuit 48, and outputs the output signal of AND circuit 46 to a switching element Q2 at the time of a powering movement, and intercepts the output signal transmission from AND circuit 47 to a switching element Q1. On the contrary, a comparator 41 controls the signal change circuit 48, and outputs the output signal of AND circuit 47 to a switching element Q1 at the time of regeneration actuation, and intercepts the output signal transmission from AND circuit 46 to a switching element Q2.
[0044] At the time of a powering movement, a comparator 42 compares the electrical potential difference VH (here, it considers as a same sign) and triangular wave electrical potential difference of high potential power-source Rhine VH, and inputs a comparison result into AND circuit 46. The pulse width (namely, PWM duty ratio) of the pulse voltage (high-level period) to which a comparator 42 outputs what are careful of is becoming so small that the electrical potential difference VH of high potential power-source Rhine VH becoming large. Thereby, if the electrical potential difference VH of high potential power-source Rhine VH becomes large, the ON time amount of a switching element Q2 will decrease, and the electrical potential difference VH of high potential power-source Rhine VH will fall.
[0045] Since AND circuit 46 permits the high-level output of a comparator 42 only within the period when a comparator 43 outputs high level, it turns out at the time of a powering movement that the maximum duty ratio of a switching element Q2 is specified with the ** analog threshold electrical potential difference Vref1 at the time of the above-mentioned powering movement.
[0046] At the time of regeneration actuation, a comparator 45 compares the electrical potential difference VH (here, it considers as a same sign) and triangular wave electrical potential difference of high potential power-source Rhine VH, and inputs a comparison result into AND circuit 47. The pulse width (namely, PWM duty ratio) of the pulse voltage (high-level period) to which a comparator 45 outputs what are careful of is becoming so large that the electrical potential difference VH of high potential power-source Rhine VH becoming large. Thereby, if the electrical potential difference VH of high potential power-source Rhine VH becomes large, the ON time amount of a switching element Q1 can increase, and a high current can reduce the electrical potential difference VH of a sink and high potential power-source Rhine VH to the low-battery electrical power system 100.
[0047] Since AND circuit 46 permits the high-level output of a comparator 45 only within the period when a comparator 44 outputs high level, it turns out at the time of regeneration actuation that the maximum duty ratio of a switching element Q1 is specified with the ** analog threshold electrical potential difference Vref2 at the time of the above-mentioned regeneration actuation.
[0048] (The example effectiveness) As explanation was given [above-mentioned], since the maximum duty ratio different, respectively was set up at the time of a powering movement and regeneration actuation and PWM actuation of the switching element Q1 at the time of regeneration actuation is restricted to PWM actuation of the switching element Q2 at the time of a powering movement, and a list in the range of each maximum duty ratio, even if it changes from a powering movement to regeneration actuation, in this example, it can prevent that the excessive charging current flows into the low voltage dc-battery 1. Moreover, this does not give surge voltage to other components (for example, DC-DC converter for auxiliary machinery dc-battery charge) connected to power-source Rhine of the low-tension side in the time of power running / regeneration switch, either.
[0049] (Deformation mode) In the above-mentioned example, although the switching element Q2 was carried out at the time of a powering movement and PWM control of the switching element Q1 was carried out at the time of regeneration actuation, loss of diode can also be reduced by carrying out the reverse action

(complementary actuation) of the remaining switching elements to the above-mentioned switching element by which PWM control is carried out.
[0050] (Deformation mode) In the above-mentioned example, although the bidirectional DC-DC converter of a reactor chopper format was used, the bidirectional DC-DC converter using the single phase bridge type inverter circuit and transformer of a pair is also employable.
[0051] In this case, what is necessary is to restrict the maximum duty ratio of the first single phase bridge type inverter circuit to below the first predetermined value at the time of a powering movement, and just to restrict the maximum duty ratio of another single phase bridge type inverter circuit which remains at the time of regeneration actuation to below the second predetermined value.
[0052] (Deformation mode) suitable for regeneration actuation in the moment to the regeneration actuation from a powering movement of changing, or just before [its] to the switching element Q1, although feedback control of the electrical potential difference VH of high potential power-source Rhine VH was carried out to predetermined desired value before and after the change in a powering movement and regeneration actuation in the above-mentioned example -- you may perform with a predetermined duty ratio compulsorily.
[0053] (Deformation mode) In the above-mentioned example, although the transit motor was assumed as a dynamo-electric machine 5 for cars, electric power is supplied to the electric load for cars in power, and when using for torque assistance or regenerative braking the generator motor which generates engine starting power, it can also apply.
[0054]
[Example 2] Other examples are explained below with reference to drawing 3 .
[0055] This example forms the high-pressure dc-battery 8 between high potential power-source Rhine VH of the circuit diagram of drawing 1 , and touch-down Rhine, and uses it as the 2 power-source mold power unit for cars.
[0056] In this case, although a bidirectional DC-DC converter will be operated so that the electrical potential difference of the low voltage dc-battery 1 may be maintained to a predetermined value if bidirectional DC-DC converter 2 says further so that power may be mutually accommodated between the high-pressure dc-battery 8 and the low voltage dc-battery 1 When the electrical potential difference of high potential power-source Rhine VH shown in drawing 2 deviates from the predetermined range at this time, the switching elements Q1 and Q2 of bidirectional DC-DC converter 2 can be operated so that it may be completed as the above-mentioned predetermined range by the electrical potential difference of high potential power-source Rhine VH.
[0057] If it does in this way, the effectiveness of being in the tolerance of the low voltage dc-battery 1, and being able to make the burden of charge of the high-pressure dc-battery 8 and discharge share in part with the low voltage dc-battery 1 can be done so.
[0058] Since the control action of a concrete bidirectional DC-DC converter itself is the same as that of the case of the example 1 shown in drawing 2 , detailed explanation is omitted.

[Translation done.]



[Drawing 3]



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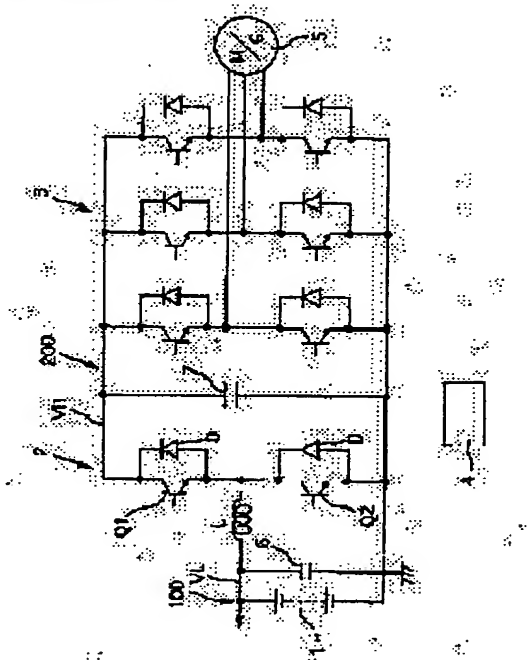
(54) DRIVE GEAR FOR AUTOMOTIVE DYNAMO-ELECTRIC MACHINE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a drive gear for an automotive dynamo-electric machine that can suppress voltage fluctuations of the power source caused by the operating condition of the power-fed automotive dynamo-electric machine being switched.
SOLUTION: The duty ratio of the switching elements Q1, Q2 on the DC-DC converter is feedback controlled in order to make the voltage 200 of the high voltage power source system 200 converge within a prescribed target range. If switching occurs between power operation and regenerative operation in controlling the switching elements Q1, Q2, the sharp change of the circuit condition during switching may cause a sharp change in the voltage and current on the low voltage power source system 100, adversely affecting the battery 1 and other low voltage components of the low voltage power source system 100. Therefore, the power transmission direction of the DC-DC converter 2 is switched before and after switching, as well as the maximum duty ratio of the switching elements Q1, Q2 so that the voltage and the current of the low voltage power source system 100 stay within the tolerance of the battery 1 of the low voltage power source system 100.



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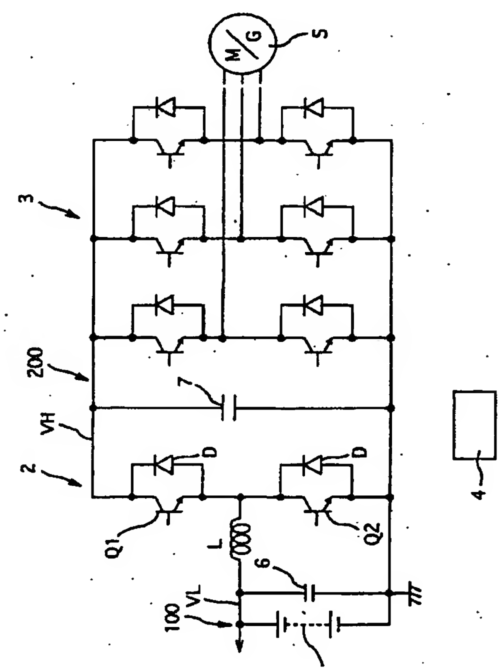
(54)【発明の名称】　車両用回転電機駆動装置

(57)【要約】
【課題】給電する車両用回転電機の動作状態切り替えによる電源系の電圧変動を抑止可能な車両用回転電機駆動装置を提供すること。
【解決手段】ＤＣ－ＤＣコンバータ２のスイッチング素子Ｑ１、Ｑ２のデューティ比を高電圧電源系２００の電圧ＶＨを所定の目標範囲に収束させるようにフィードバック制御する。この場合、スイッチング素子Ｑ１、Ｑ２の制御を力行動作と回生動作とで切り替えが生じると、切り替え時の回路状態急変により低電圧電源系１００の電圧や電流が急変し、低電圧電源系１００のバッテリ１や他の低圧系のコンポーネントに悪影響を与える可能性がある。そこで、切り替え前後において、ＤＣ－ＤＣコンバータ２の送電方向切り替えと同時に、低電圧電源系１００の電圧や電流が低電圧電源系１００のバッテリ１の許容範囲内に収まるようにスイッチング素子Ｑ１、Ｑ２の最大デューティ比を切り替える。



【特許請求の範囲】

【請求項１】走行動力の発生、回生の少なくとも一部を担当する高電圧の車両用回転電機とインバータ装置を通じて双方向電力授受する高電圧電源系と、
低電圧のバッテリを有して前記高電圧電源系よりも低電圧を発生する低電圧電源系と、
前記両電源系の間に配置されて前記両電源系間の双方向電力授受を制御するＤＣ－ＤＣコンバータと、
前記ＤＣ－ＤＣコンバータに内蔵されるスイッチング素子をＰＷＭ制御する制御部と、
を備える車両用回転電機駆動装置において、
前記制御部は、
前記高電圧電源系の電圧を所定の目標範囲に収束させるように前記スイッチング素子のデューティ比をフィードバック制御するとともに、前記車両用回転電機の力行動作と回生動作との切り替えに応じて、又は、前記切り替えに伴う前記高電圧電源系の電圧変化に応じて、前記スイッチング素子の最大デューティ比を前記低電圧電源系の電圧変動抑制方向に切り替えることを特徴とする車両用双方向ＤＣ－ＤＣコンバータ装置。

【請求項２】請求項１記載の車両用回転電機駆動装置において、
前記ＤＣ－ＤＣコンバータは、
互いに直列接続されて前記高電圧電源系の両端に接続されるハイサイド側の前記スイッチング素子及びローサイド側の前記スイッチング素子と、前記両スイッチング素子の接続点と前記低電圧電源系の高位端とを接続するリアクトルとを有し、
前記制御部は、
前記高電圧電源系から前記低電圧電源系への送電時すなわち前記回生動作時に前記ハイサイド側のスイッチング素子を第一の最大デューティ比の範囲内でＰＷＭ制御し、前記低電圧電源系から前記高電圧電源系への送電時すなわち前記力行動作時に前記ローサイド側のスイッチング素子を第二の最大デューティ比の範囲内でＰＷＭ制御することを特徴とする車両用回転電機駆動装置。

【請求項３】請求項１記載の車両用回転電機駆動装置において、
前記制御部は、
前記バッテリの温度又は電流に関連する検出信号に基づいて、前記最大デューティ比を変更することを特徴とする車両用回転電機駆動装置。

【請求項４】高電圧のバッテリを有して走行動力の発生、回生の少なくとも一部を担当する高電圧の車両用回転電機とインバータ装置を通じて双方向電力授受する高電圧電源系と、
低電圧のバッテリを有して前記高電圧電源系よりも低電圧を発生する低電圧電源系と、
前記両電源系の間に配置されて前記両電源系間の双方向電力授受を制御するＤＣ－ＤＣコンバータと、
前記ＤＣ－ＤＣコンバータに内蔵されるスイッチング素子をＰＷＭ制御する制御部と、
を備える車両用回転電機駆動装置において、
前記制御部は、前記車両用回転電機の動作状態の急変に応じて、又は、前記急変に伴う前記高電圧電源系の急変に応じて、前記低電圧のバッテリの許容電流範囲内で前記高電圧電源系の電圧変動を抑制する向きに自己の送電状態を制御することを特徴とする車両用回転電機駆動装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、車両用回転電機駆動装置に関し、詳しくは双方向ＤＣ－ＤＣコンバータを有する車両用回転電機駆動装置に関する。

【０００２】

【従来の技術】走行動力の発生、回生だけを行う車両用回転電機や、それらの動作としてのトルクアシスト動作や回生制動動作に加えて更にエンジン始動動作や車両電気負荷給電用の発電動作を行う車両用回転電機が知られている。このように電動動作と発電動作を適宜切り替えることができる車両用回転電機としては、インバータ回路により交流駆動されるブラシレス同期機が採用されるのが通常である。

【０００３】これらの車両用回転電機は、回転電機やそれを駆動するインバータ回路の小型化や効率向上のためにできるだけ高電圧仕様とすることが望ましいが、車載バッテリは定められた所定の低電圧定格のものを用いざるを得ないため、車載バッテリとインバータ回路との間に双方向電力授受可能なＤＣ－ＤＣコンバータを介設する必要がある。

【０００４】

【発明が解決しようとする課題】しかしながら、上記した双方向ＤＣ－ＤＣコンバータをもち車両用回転電機に給電する車両用回転電機駆動装置では、車両用回転電機の電動動作と発電動作との切り替え時に回路状態の急変により低電圧電源系又は高電圧電源系の電圧がオーバーシュートして過大となり、バッテリやそれに接続される電気機器に悪影響を与える可能性がある。

【０００５】本発明は上記問題点に鑑みなされたものであり、給電する車両用回転電機の動作状態切り替えによる電源系の電圧変動を抑止可能な車両用回転電機駆動装置を提供することを、その目的としている。

【０００６】

【課題を解決するための手段】請求項１記載の車両用回転電機駆動装置は、走行動力の発生、回生の少なくとも一部を担当する高電圧の車両用回転電機とインバータ装置を通じて双方向電力授受する高電圧電源系と、低電圧のバッテリを有して前記高電圧電源系よりも低電圧を発生する低電圧電源系と、前記両電源系の間に配置されて前記両電源系間の双方向電力授受を制御するＤＣ－ＤＣ

コンバータと、前記ＤＣ－ＤＣコンバータに内蔵されるスイッチング素子をＰＷＭ制御する制御部とを備える車両用回転電機駆動装置において、前記制御部は、前記高電圧電源系の電圧を所定の目標範囲に収束させるように前記スイッチング素子のデューティ比をフィードバック制御するとともに、前記車両用回転電機の力行動作と回生動作との切り替えに応じて、又は、前記切り替えに伴う前記高電圧電源系の電圧変化に応じて、前記スイッチング素子の最大デューティ比を前記低電圧電源系の電圧変動抑制方向に切り替えることを特徴としている。

【０００７】すなわち、本構成によれば、ＤＣ－ＤＣコンバータのスイッチング素子のデューティ比を高電圧電源系の電圧を所定の目標範囲に収束させるようにフィードバック制御する。この場合、スイッチング素子の制御を力行動作と回生動作とで切り替えが生じると、切り替え時の回路状態急変により低電圧電源系の電圧や電流が急変し、低電圧電源系のバッテリに悪影響が生じる。

【０００８】そこで、本構成では、切り替え前後において、ＤＣ－ＤＣコンバータの送電方向切り替えと同時に、低電圧電源系の電圧や電流が低電圧電源系のバッテリの許容範囲内に収まるようにスイッチング素子の最大デューティ比の値も同時に切り替える。これにより、ＤＣ－ＤＣコンバータの動作状態（送電方向）の切り替え時に低電圧電源系の電源ラインに重畳するオーバーシュート電圧を抑制することができるので、バッテリへの悪影響を抑止しつつ、車両用回転電機の動作モードの切り替えを実行することができる。

【０００９】請求項２記載の構成は請求項１記載の車両用回転電機駆動装置において更に、前記ＤＣ－ＤＣコンバータが、互いに直列接続されて前記高電圧電源系の両端に接続されるハイサイド側の前記スイッチング素子及びローサイド側の前記スイッチング素子と、前記両スイッチング素子の接続点と前記低電圧電源系の高位端とを接続するリアクトルとを有し、前記制御部が、前記高電圧電源系から前記低電圧電源系への送電時すなわち前記回生動作時に前記ハイサイド側のスイッチング素子を第一の最大デューティ比の範囲内でＰＷＭ制御し、前記低電圧電源系から前記高電圧電源系への送電時すなわち前記力行動作時に前記ローサイド側のスイッチング素子を第二の最大デューティ比の範囲内でＰＷＭ制御することを特徴としている。

【００１０】すなわち、本構成によれば、簡素な構成で上記請求項１記載の効果を実現することができる。

【００１１】請求項３記載の構成は請求項１記載の車両用回転電機駆動装置において更に、前記制御部が、前記バッテリの温度又は電流に関連する検出信号に基づいて、前記最大デューティ比を変更することを特徴としている。

【００１２】本構成によれば、低電圧電源系のバッテリの許容電圧（充電時最大電圧と放電時最小電圧）がその

温度や電流に応じて変動するのに合わせて、上記バッテリ充電時の最大デューティ比及び上記バッテリの放電時の最大デューティ比をそれぞれ変化させるので、バッテリの温度や電流が変化しても上記切り替えによるバッテリへの悪影響の増大を回避することができる。

【００１３】請求項４記載の車両用回転電機駆動装置は、高電圧のバッテリを有して走行動力の発生、回生の少なくとも一部を担当する高電圧の車両用回転電機とインバータ装置を通じて双方向電力授受する高電圧電源系と、低電圧のバッテリを有して前記高電圧電源系よりも低電圧を発生する低電圧電源系と、前記両電源系の間に配置されて前記両電源系間の双方向電力授受を制御するＤＣ－ＤＣコンバータと、前記ＤＣ－ＤＣコンバータに内蔵されるスイッチング素子をＰＷＭ制御する制御部とを備える車両用回転電機駆動装置において、前記制御部が、前記車両用回転電機の動作状態の急変に応じて、又は、前記急変に伴う前記高電圧電源系の急変に応じて、前記低電圧のバッテリの許容電流範囲内で前記高電圧電源系の電圧変動を抑制する向きに自己の送電状態を制御することを特徴としている。

【００１４】すなわち、本構成によれば、高電圧電源系及び低電圧電源系がそれぞれバッテリを有する二電源系において、高電圧電源系のバッテリの電圧変動を抑止するために低電圧電源系のバッテリの許容範囲でＤＣ－ＤＣコンバータを駆動制御するので、高電圧電源系の電圧変動を低減することができる。

【００１５】

【発明の実施の形態】本発明の車両用回転電機駆動装置の好適な実施態様を図１を参照して説明する。

【００１６】（全体構成）１は低電圧電源系１００のバッテリ（低圧バッテリ）、２は双方向ＤＣ－ＤＣコンバータ（ＤＣ－ＤＣコンバータ）、３は三相のインバータ回路、４はＤＣ－ＤＣコンバータ制御用のコントローラ（制御部）、５は車両走行モータをなす同期機、６、７は平滑コンデンサである。

【００１７】ＤＣ－ＤＣコンバータ２は、リアクトルＬと、それぞれフライホイルダイオードＤを有するＩＧＢＴからなるハイサイド側のスイッチング素子Ｑ１及びローサイド側のスイッチング素子Ｑ２とからなる。リアクトルＬは、両スイッチング素子Ｑ１、Ｑ２の接続点と低圧バッテリ１の高位端とを接続し、ハイサイド側のスイッチング素子Ｑ１の他端は高電圧電源系２００の高電位電源ラインＶＨに接続され、ローサイド側のスイッチング素子Ｑ２の他端は接地されている。ＶＬは低電圧電源系１００の高電位電源ラインであり、リアクトルＬと低圧バッテリ１の高位端とを接続している。

【００１８】インバータ回路３は、６個のＩＧＢＴと６個のフライホイルダイオードとを一対づつ逆並列接続してなる周知の三相インバータ回路であって、高電圧電源系２００の直流高電圧を三相交流電圧に変換して三相同

期機５の電機子コイルに印加している。インバータ回路３は、図示しないインバータ制御用コントローラに制御されて、同期機５の回転子位置に応じて所定の位相の三相交流電圧を同期機５の電機子巻線に印加する。なお、この三相交流電圧の上記所定の位相は発電動作時と電動動作時とで異なる。すなわち、上記インバータ制御用コントローラは車両の要求に応じて、同期機５の回転子位置を基準として三相交流電圧の上記所定の位相を変更することにより、同期機５の発電動作と電動動作とを切り替える。これらの制御はもはや周知であるので、更に詳しい説明は省略する。

【００１９】コントローラ４は、高電位電源ラインＶＨの電圧が所定目標値になるようにフィードバック制御するとともに、双方向ＤＣ－ＤＣコンバータ２の動作モード切替に際してそのデューティ比を所定の最大デューティ比未満に制限する機能を有している。

【００２０】（基本動作）車両用回転電機５の電動動作（力行動作）時と、発電動作（回生動作）時とで動作が異なるので、両動作を順次説明する。

【００２１】まず、電動動作（力行動作）におけるＤＣ－ＤＣコンバータ制御の基本を以下に説明する。

【００２２】電動動作（力行動作）には低圧バッテリ１が必要電力をインバータ回路に給電する必要がある。

【００２３】そこで、コントローラ４は、ローサイド側のスイッチング素子Ｑ２を第一のデューティ比の範囲内でＰＷＭスイッチングする。すなわち、スイッチング素子Ｑ２をオンすると低圧バッテリ１からリアクトルＬ、スイッチング素子Ｑ２を通じて電流が流れ、リアクトルＬに電磁エネルギーが蓄積され、スイッチング素子Ｑ２を遮断するとリアクトルＬは電流状態を持続しようとしてハイサイド側のスイッチング素子Ｑ１と逆並列に接続したフライホイルダイオードＤを通じて高電位電源ラインＶＨに電流を流す。以下、低圧バッテリ１はこの繰り返しにより持続的にインバータ回路３に直流電力を給電する。

【００２４】また、コントローラ４は、高電位電源ラインＶＨの電圧の増加によりスイッチング素子Ｑ２のデューティ比を減少し、高電位電源ラインＶＨの電圧の減少によりスイッチング素子Ｑ２のデューティ比を増大するフィードバック制御を行っている。

【００２５】これにより、高電位電源ラインＶＨの電圧が増加するとスイッチング素子Ｑ２のデューティ比減少によりリアクトルＬの蓄積電磁エネルギーが減少してＤＣ－ＤＣコンバータ２の出力電圧が低下し、逆に、高電位電源ラインＶＨの電圧が減少するとスイッチング素子Ｑ２のデューティ比増大によりリアクトルＬの蓄積電磁エネルギーが増大してＤＣ－ＤＣコンバータ２の出力電圧が増加し、高電位電源ラインＶＨの電圧は所定範囲に維持される。

【００２６】したがって、スイッチング素子Ｑ２のデューティ比の増加は、低圧バッテリ１の放電電流の増大を招く。そこで、低圧バッテリ１の放電電流が許容最大放電電流値未満となるように、スイッチング素子Ｑ２のデューティ比を所定の最大デューティ比未満に制限する。なお、スイッチング素子Ｑ２の断続と逆のパターンで（相補的に）スイッチング素子Ｑ１を断続してもよい。

【００２７】次に、発電動作（回生動作）におけるＤＣ－ＤＣコンバータの制御の基本を以下に説明する。

【００２８】発電動作（回生動作）時には低圧バッテリ１が必要電力をインバータ回路から吸収する必要がある。

【００２９】そこで、コントローラ４は、ハイサイド側のスイッチング素子Ｑ１を第二のデューティ比の範囲内でＰＷＭスイッチングする。すなわち、スイッチング素子Ｑ１をオンすると高電位電源ラインＶＨからリアクトルＬを通じて低圧バッテリ１に電流が流れ、リアクトルＬに電磁エネルギーが蓄積され、スイッチング素子Ｑ１を遮断するとリアクトルＬは電流状態を持続しようとしてローサイド側のスイッチング素子Ｑ２と逆並列に接続したフライホイルダイオードＤを通じて低圧バッテリ１に電流を流す。以下、低圧バッテリ１はこの繰り返しにより持続的にインバータ回路３から直流電力を給電される。

【００３０】また、コントローラ４は、高電位電源ラインＶＨの電圧の増加によりスイッチング素子Ｑ１のデューティ比を増大し、高電位電源ラインＶＨの電圧の減少によりスイッチング素子Ｑ２のデューティ比を減少するフィードバック制御を行っている。

【００３１】これにより、高電位電源ラインＶＨの電圧が増加するとスイッチング素子Ｑ１のデューティ比増加によりリアクトルＬの蓄積電磁エネルギーやバッテリ充電電流が増加して高電位電源ラインＶＨの電圧が低下し、逆に、高電位電源ラインＶＨの電圧が減少するとスイッチング素子Ｑ１のデューティ比減少によりリアクトルＬの蓄積電磁エネルギーやバッテリ充電電流が減少して高電位電源ラインＶＨの電圧が増大し、高電位電源ラインＶＨの電圧は所定範囲に維持される。

【００３２】したがって、スイッチング素子Ｑ１のデューティ比の増加は、低圧バッテリ１の充電電流の増大を招く。そこで、低圧バッテリ１の充電電流が許容最大充電電流値未満となるように、スイッチング素子Ｑ１のデューティ比を所定の最大デューティ比未満に制限する。なお、スイッチング素子Ｑ１の断続と逆のパターンで（相補的に）スイッチング素子Ｑ２を断続してもよい。

【００３３】更に説明すると、低電圧電源系１００の高電位電源ラインＶＬの電圧は、充電時と放電時とで変化する。これは、低圧バッテリ１の充電時の印加電圧はその開放電圧よりも高く設定しなければ充電をなし得ないが、低圧バッテリ１の放電時の端子電圧はその内部抵抗による電圧降下により開放電圧よりも低くならざるを得

ないためである。電動動作（力行動作）時と発電動作（回生動作）時とにおける上記低電圧電源系１００の高電位電源ラインＶＬの電圧変更は、強制的に行ってもよいが、上記高電位電源ラインＶＨを一定化するためのフィードバック制御にまかせるだけでも自然に実施することができる。

【００３４】すなわち、回生動作時に低圧バッテリ１の充電がうまくいかなければ高電位電源ラインＶＨの電圧は急速に高くなるので、それに応じて、スイッチング素子Ｑ１のデューティ比が急速に増大して、低電圧電源系１００の高電位電源ラインＶＬの電圧が上昇し、バッテリ１の充電が円滑にできるようになる。逆に、力行動作に低圧バッテリ１の充電がうまくいかなければ高電位電源ラインＶＨの電圧は急速に低下するので、それに応じて、スイッチング素子Ｑ２のデューティ比が急速に増大して、低電圧電源系１００の高電位電源ラインＶＬの電圧が低下し、バッテリ１の放電が円滑にできるようになる。

【００３５】その他、上記フィードバック制御に任せることなく、回生動作から電動動作への切り替えにおいてスイッチング素子Ｑ２のデューティ比を所定短時間だけ所定値に強制セットし、これにより、速やかに低圧バッテリ１から高電位電源ラインＶＨへ電力を供給して高電位電源ラインＶＨの電圧低下を防止し、逆に、電動動作から回生動作への切り替えにおいてスイッチング素子Ｑ１のデューティ比を所定短時間だけ所定値に強制セットし、これにより、速やかに高電位電源ラインＶＨから低圧バッテリ１へ電力を供給して高電位電源ラインＶＨの電圧増大を防止することもできる。もちろん、この場合には、上記所定短時間経過後は、通常の上記フィードバック制御に戻る必要がある。

【００３６】（コントローラ４の説明）次に、上記したＤＣ－ＤＣコンバータの制御を行うコントローラ４について図２を参照して更に詳しく説明する。

【００３７】４０はアナログしきい値電圧用のマイコン、４１～４５はコンパレータ、４６、４７はＡＮＤ回路、４８は切り替え回路である。

【００３８】マイコン４０は、力行動作時におけるスイッチング素子Ｑ２の最大デューティ比と、回生動作時におけるスイッチング素子Ｑ１の最大デューティ比とを設定するマイコンである。マイコン４０には、低圧バッテリ１の温度と電流に比例するアナログ信号電圧が図示しないセンサから入力され、これらアナログ信号電圧はマイコン４０に内蔵されたＡ／Ｄコンバータによりデジタル信号に変換される。

【００３９】マイコン４０は、入力された低圧バッテリ１の温度と電流に応じて力行動作時のスイッチング素子Ｑ２の最大デューティ比と、回生動作時のスイッチング素子Ｑ１の最大デューティ比とを補正する。具体的に説明すると、マイコン４０は、低圧バッテリ１の温度と電流と最大デューティ比補正量との関係を示すマップを保持しており、入力された温度、電流に応じてマップから最大デューティ比の補正量を求める。更に説明すると、低圧バッテリ１の温度が高ければ、最大デューティ比を小さくする方向に補正量を変更し、低圧バッテリ１の電流が大きければ最大デューティ比を小さくする方向に補正量を変更する。これにより、低圧バッテリ１の温度が高いか又は電流が大きい場合には、最大デューティ比を小さくして低圧バッテリ１の最大電流を低下し、その追加発熱又は追加電流の増大による低圧バッテリ１の仕様条件悪化を防止することができる。

【００４０】マイコン４０で求められた力行動作時のスイッチング素子Ｑ２の最大デューティ比と、回生動作時のスイッチング素子Ｑ１の最大デューティ比とは、マイコン４０内でＤ／Ａ変換されてコンパレータ４３、４５に個別に出力される。なお、Ｖref１は力行動作時のスイッチング素子Ｑ２の最大デューティ比に相当するアナログしきい値電圧であり、Ｖref２は回生動作時のスイッチング素子Ｑ１の最大デューティ比に相当するアナログしきい値電圧である。

【００４１】コンパレータ４１は、力行動作と回生動作とを判別する回路であるが、これを省略して上記したインバータ回路３を制御するコントローラから力行動作と回生動作とを区別する信号を受信してもよい。

【００４２】更に説明すると、力行動作時と回生動作時とでは、高電圧電源系２００の高電位電源ラインＶＨの電圧はかなり異なり、それは力行動作時に低く、回生動作時に高くなるので、コンパレータ４１は、回生動作時にがハイレベルを出力し、力行動作時にローレベルを出力する。

【００４３】コンパレータ４１は、信号切り替え回路４８を制御して、力行動作時に、ＡＮＤ回路４６の出力信号をスイッチング素子Ｑ２に出力し、かつ、ＡＮＤ回路４７からスイッチング素子Ｑ１への出力信号伝送を遮断する。逆に、コンパレータ４１は、信号切り替え回路４８を制御して、回生動作時に、ＡＮＤ回路４７の出力信号をスイッチング素子Ｑ１に出力し、かつ、ＡＮＤ回路４６からスイッチング素子Ｑ２への出力信号伝送を遮断する。

【００４４】力行動作時には、コンパレータ４２は高電位電源ラインＶＨの電圧ＶＨ（ここでは同符号とする）と三角波電圧とを比較して、比較結果をＡＮＤ回路４６に入力する。注意することは、コンパレータ４２が出力するパルス電圧（ハイレベル期間）のパルス幅（すなわちＰＷＭデューティ比）は、高電位電源ラインＶＨの電圧ＶＨが大きくなるほど小さくなることである。これにより、高電位電源ラインＶＨの電圧ＶＨが大きくなるとスイッチング素子Ｑ２のオン時間が減少して高電位電源ラインＶＨの電圧ＶＨが低下する。

【００４５】ＡＮＤ回路４６は、コンパレータ４３がハ

イレベルを出力する期間内でのみ、コンパレータ４２のハイレベル出力を許可するので、力行動作時にスイッチング素子Ｑ２の最大デューティ比は、上記力行動作時用アナログしきい値電圧Vref１により規定されることがわかる。

【００４６】回生動作時には、コンパレータ４５は高電位電源ラインＶＨの電圧ＶＨ（ここでは同符号とする）と三角波電圧とを比較して、比較結果をＡＮＤ回路４７に入力する。注意することは、コンパレータ４５が出力するパルス電圧（ハイレベル期間）のパルス幅（すなわちＰWMデューティ比）は、高電位電源ラインＶＨの電圧ＶＨが大きくなるほど大きくなることである。これにより、高電位電源ラインＶＨの電圧ＶＨが大きくなるとスイッチング素子Ｑ１のオン時間が増大して大電流を低電圧電源系１００へ流し、高電位電源ラインＶＨの電圧ＶＨを低下させることができる。

【００４７】ＡＮＤ回路４６は、コンパレータ４４がハイレベルを出力する期間内でのみ、コンパレータ４５のハイレベル出力を許可するので、回生動作時にスイッチング素子Ｑ１の最大デューティ比は、上記回生動作時用アナログしきい値電圧Vref２により規定されることがわかる。

【００４８】（実施例効果）上記説明したように、この実施例では、力行動作時と回生動作時にそれぞれ異なる最大デューティ比を設定し、力行動作時のスイッチング素子Ｑ２のＰWM動作、並びに、回生動作時のスイッチング素子Ｑ１のＰWM動作をそれぞれの最大デューティ比の範囲に制限しているので、力行動作から回生動作に切り替えたとしても、低圧バッテリ１に過大な充電電流が流れ込むことを防止することができる。また、それにより、低圧側の電源ラインに接続されるほかのコンポーネント（たとえば補機バッテリ充電用のＤＣ－ＤＣコンバータ）に力行／回生切り換え時でもサージ電圧を与えることがない。

【００４９】（変形態様）上記実施例では、力行動作時にはスイッチング素子Ｑ２を、回生動作時にはスイッチング素子Ｑ１をＰWM制御させたが、残りのスイッチング素子を上記ＰWM制御されるスイッチング素子と逆動作（相補動作）させることにより、ダイオードの損失を低減することもできる。

【００５０】（変形態様）上記実施例では、リアクトルチョッパ形式の双方向ＤＣ－ＤＣコンバータを用いたが、一対の単相ブリッジ型インバータ回路とトランスとを用いた双方向ＤＣ－ＤＣコンバータを採用することもできる。

【００５１】この場合には、力行動作時に第一の単相ブリッジ型インバータ回路の最大デューティ比を第一の所定値以下に制限し、回生動作時には残るもう一つの単相ブリッジ型インバータ回路の最大デューティ比を第二の所定値以下に制限すればよい。

【００５２】（変形態様）上記実施例では、力行動作と回生動作との切り替え前後において高電位電源ラインＶＨの電圧ＶＨを所定目標値にフィードバック制御していたが、力行動作から回生動作への切り替えた瞬間又はその直前からスイッチング素子Ｑ１を回生動作に好適な強制的に所定のデューティ比で実行するしてもよい。

【００５３】（変形態様）上記実施例では、車両用回転電機５として走行モータを想定したが、車両用電気負荷に電力を給電し、エンジン始動動力を発生する発電電動機をトルクアシストや回生制動に用いる場合に適用することもできる。

【００５４】

【実施例２】他の実施例を図３を参照して以下に説明する。

【００５５】この実施例は、図１の回路図の高電位電源ラインＶＨと接地ラインの間に高圧バッテリ８を設けて車両用二電源型電源装置としたものである。

【００５６】この場合には、双方向ＤＣ－ＤＣコンバータ２は高圧バッテリ８と低圧バッテリ１との間で電力を融通し合うように、更に言えば、低圧バッテリ１の電圧を所定値に維持するように双方向ＤＣ－ＤＣコンバータが運転されるが、この時、図２に示す高電位電源ラインＶＨの電圧が所定範囲を逸脱した場合に、高電位電源ラインＶＨの電圧が上記所定範囲に収束するように双方向ＤＣ－ＤＣコンバータ２のスイッチング素子Ｑ１、Ｑ２を動作させることができる。

【００５７】このようにすれば、高圧バッテリ８の充電、放電の負担を低圧バッテリ１の許容範囲内で低圧バッテリ１により一部分担させることができるという効果を奏することができる。

【００５８】具体的な双方向ＤＣ－ＤＣコンバータの制御動作自体は図２に示す実施例１の場合と同様であるので、詳細な説明は省略する。

【図面の簡単な説明】

【図１】本発明の車両用回転電機駆動装置の一実施例を示す回路図である。

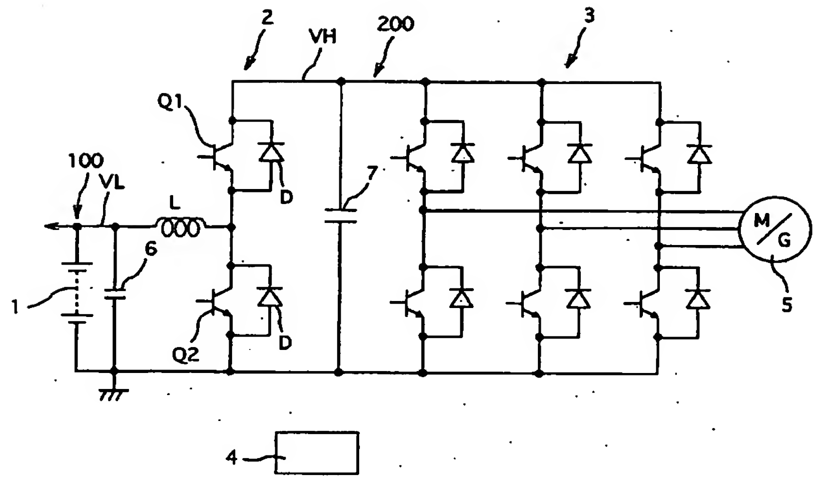
【図２】図１のコントローラの一例を示す回路図である。

【図３】本発明の車両用回転電機駆動装置の他実施例を示す回路図である。

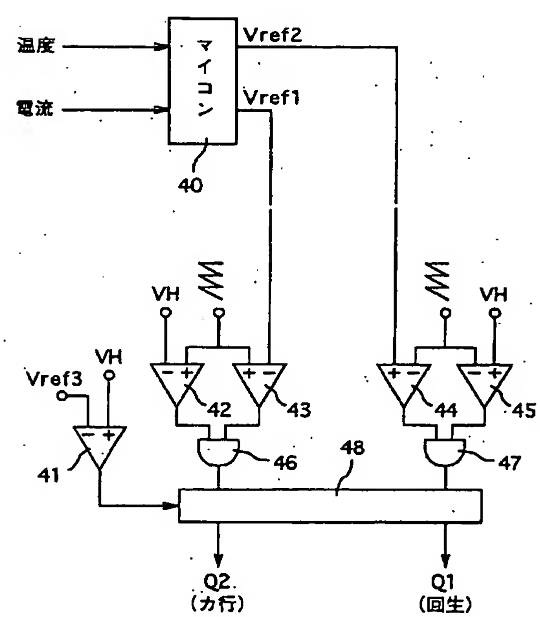
【符号の説明】

１は低圧バッテリ（バッテリ）、２はＤＣ－ＤＣコンバータ、３はインバータ回路、４はコントローラ（制御部）、５は同期機（車両用回転電機）、Ｑ１はハイサイド側のスイッチング素子、Ｑ２はローサイド側のスイッチング素子、Ｄはフライホイルダイオード。

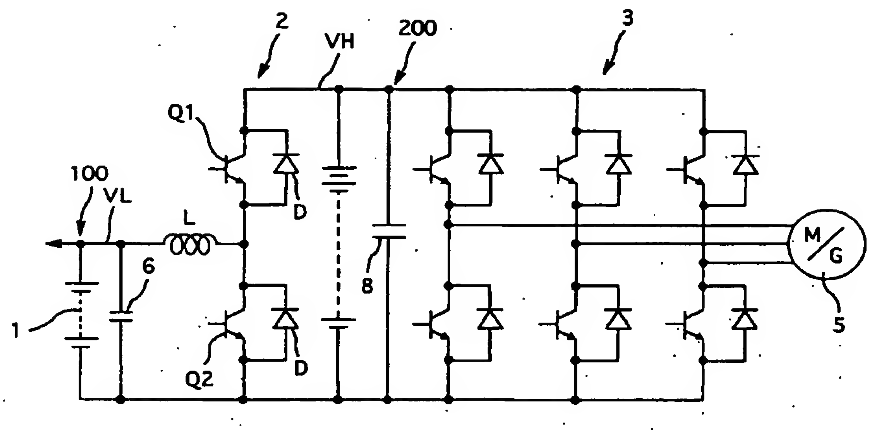
【図１】


2
VH
200
3
Q1
100
VL
L
D
7
6
1
Q2
D
M
G
5
4

【図２】


温度
電流
マイコン
Vref2
Vref1
40
VH
VH
VH
Vref3
42
43
44
45
41
46
48
47
Q2
(力行)
Q1
(回生)

【図３】



フロントページの続き

Ｆターム(参考)　5H115 PG04 PI16 PU02 PV03 QN06
RB22 SE03 SE06 TI06 TI09
TR19 TU01 TU11
5H590 AA01 AA24 AB02 AB03 AB20
CC01 CC24 CD01 CD03 CD10
CE05 DD32 EA10 EB00 FA08
FB02 FC12 FC17 FC22 GA04
HA04 HA18 JA03 JB04 JB13
5H730 AA01 AS01 AS13 AS17 BB06
BB57 BB82 CC25 DD02 EE07
EE59 FD41 FD61 FF02 FG05
FG11 FG12 FG23 XX02 XX03
XX15 XX19 XX22 XX23 XX35
XX38 XX41